Attorney Docket: 46107-0037
Serial No. 10/608,906
Reply to Notice of Allowance of June 28, 2006

AMENDMENTS TO THE SPECIFICATION

Please replace or amend the following paragraphs of the specification.

Please amend paragraph **[0007]** at page 2, as follows:

[0007] As is discussed in detail in this application, one feature of the present invention is the use of electromagnetic retarders, preferably eddy current machines, as YSC braking devices. While electromagnetic retarders have been used in braking systems for commercial trucks for many years, these retarders are generally not used in YSC systems for a number of reasons, including difficulty in accurately modeling the torque characteristics of the retarder. One modeling consideration of particular interest in YSC systems is the ability to obtain an accurate estimation of the retarding torque generated by an electromagnetic retarder. Accurate torque estimation is important for providing consistent performance. One conventional estimation technique requires an initial estimation of armature temperature which is then used in the torque calculation. Others have estimated electromagnetic retarder braking torques using predetermined look up tables of torque versus peak voltage between the retarder poles at various rotor speeds. Yet others have modeled eddy current brakes as a function of excitation current and rotor speed. However, each of the aforementioned techniques [[suffer]] <u>suffers</u> from inaccuracies, assumptions that are not appropriate for many operating conditions, and/or computational intensity.

Please amend paragraph **[0018]** at page 5, as follows:

[0018] Figure 2 is a ~~schematic~~ <u>flowchart illustrating an</u> overview of the control unit control strategy;

Please amend paragraph **[0026]** at page 6, as follows:

[0026] Figure 1(a) schematically illustrates a vehicle 10 having a plurality of wheels 12 rotating with shafts 14. The vehicle includes a YSC system [[16]] illustrated to include braking devices 18a-18d associated with each of the wheels, a yaw rate sensor 20, and a control unit 22. During operation, any change in the direction of the vehicle 10 generates a yaw rate about the vehicle's center of gravity (CG) 24. While a certain yaw rate is desired for proper vehicle turning, the vehicle operator may place the vehicle in oversteer or understeer conditions where the vehicle yaw rate differs from the desired yaw rate.

The control unit 22 seeks to identify and correct the tracking error between the measured vehicle yaw rate and the desired yaw rate.

Please amend paragraph [0027] at page 6, as follows:

[0027] The YSC system [[16]] uses a systematic approach to control vehicle yaw rates. This systematic approach, based in part on using a sliding mode control law in combination with a lumped mass vehicle model to determine a control yaw moment, improves the system response time, enhances vehicle yaw rate tracking to the desired yaw rate, and improves controller robustness and stability when compared to conventional systems. The YSC system described in detail herein uses electromagnetic retarders, particularly though not necessarily eddy current machines, as the braking devices 18. While the use of electromagnetic retarders provides numerous operational benefits over conventional systems it should be recognized that the control strategy may be used with YSC systems incorporating other braking mechanisms, including friction brakes.

Please amend paragraph [0028] beginning on page 6, as follows:

[0028] An electromagnetic retarder or brake [[30]] suitable for use as a braking device is illustrated in Figure 4. Retarders of the type illustrated in Figure 4 and described herein are generally known in the art and follow the basic principles of electromagnetic induction. In general, the retarder [[30]] (illustrated as an eddy current machine) has an iron core 32, a stator 34, conductive windings 35, and a rotor 36 fixed to rotate with the wheel shaft (not shown). Providing the stator windings 35 with an excitation current induces an eddy current in the stator and a retarding force which acts on the rotor 36. A conventional sensor monitors the rotational speed of the rotor 36 and communicates a rotational velocity signal to the control unit 22. The electromagnetic retarders may be used as secondary retarders for each vehicle wheel or as the primary braking system for the vehicle.

Please amend paragraph [0029] at page 7, as follows:

[0029] The operation of the control unit 22 will now be described with reference to the flow charts illustrated in Figures 2 and 3. As an overview, the control unit 22 receives input from conventionally configured sensors or stored data and determines and communicates a current command to one or more of the electromagnetic retarders [[30]] to minimize yaw rate tracking error. The control unit 22 is generally configured in a conventional manner to carry out the tasks described herein. Thus, it will be appreciated

that the control unit 22 may take a variety of forms without departing from the scope of the present invention. By way of example, it is contemplated that the control unit 22 includes a microprocessor with a calculation module, a memory or data structure for storing and/or retrieving data, as well as appropriate input and output circuits for receiving the various input signals and communicating control commands to YSC system components such as the retarders [[30]].

Please amend paragraph **[0049]** at page 16, as follows:

[0049] As noted above, the YSC system may include different types of braking devices for generating the control yaw moment. The following description is provided with reference to the illustrated embodiment of the YSC system using electromagnetic retarders [[30]], preferably eddy current machines, operatively associated with each of the vehicle wheels 12 and, more particularly, with the rotors. The control yaw moment is generated by selectively energizing one or more of the electromagnetic retarders [[30]].

Please amend paragraph **[0061]** beginning on page 19, as follows:

[0061] Steps 90, 92, 94, and 96 in Figure 3 represent the comparison of the required torque from a single braking device (e.g., T*bRL* in Step 90) to the estimated torque that the braking device is capable of generating (e.g., *TestRL*). The torque generated by the electromagnetic retarders [[30]] is a function of rotor speed and the current supplied to each device. This relationship is illustrated by the curves shown in Figures 5 and 6. More particularly, Figure 5 shows the retarding torque versus current characteristics of the eddy current machine at various rotor speeds between 100 and 1000 RPM. Figure 6 shows the torque versus rotor speed characteristics of these machines at constant excitation current. As indicated in Figure 3, if the required torque is less than the estimated torque, the control unit 22 proceeds to Step 46 and calculates the current command according to Equation (19) below. However, if the required torque is greater than the estimated capacity of the actuator, actuator saturation prevents the inducement of the required control yaw moment.

Please amend paragraph **[0063]** beginning on page 20, as follows:

[0063] The steady state torque model for the eddy current machines is represented by the following Equation (14).

$$T_{est} = f_0(\omega) + f_1(\omega) * i + f_2(\omega) * i^2 \qquad (14)$$

where

T = retarding torque

i = retarder feedback current

$$f_i(\omega) = a_{i0} + a_{i1}\omega + a_{i2}\omega^2$$

with

ai0 , *ai1* , *ai2* = identified parameters

ω = rotor speed

The parameters *aij* (where i = 0, 1, 2 and j = 0,1,2) in Equation (14) are functions of the rotor speed and are estimated from steady state test data. The solid lines 110, 112 and 114 in Figures 7(a), 7(b), and 7(c), respectively, show plots of coefficient functions *f0, f1,* and *f2* for each rotor speed as identified through a least square estimate based on the steady state test data. The solid line plots 110, 112, and 114 of *f0, f1,* and *f2* are used for the initial estimate of the parameters *a00*, *a01*, ..., and *a22*. The coefficient functions *f0, f1,* and *f2* are then re-calculated and plotted for each rotor speed based on the initial estimates of parameters *aij*. The plots of these functions are shown by dotted lines 116, 118, and 120 in Figures 7(a)-(c). The parameters *aij* for each of the coefficient functions *f0, f1,* and *f2* are then re-estimated through another least square typc algorithm. A variety of conventional least square fitting techniques, including the MATLAB function PLYFIT, may be used for each of the above discussed least square estimations. It is apparent that the second stage fit of the coefficient function *f0, f1,* and *f2* (shown by dotted lines 116, 118, and 120) match reasonably well with the first stage estimate of the coefficient functions directly from experimental data. Accordingly, Figures 7(a)-(c) graphically illustrate that the torque produced by the retarder [[30]] is accurately modeled using a quadratic function of the excitation current and the rotor speed.